ميكانيكا قوى جديد

Tanta University	Department: Mechanical Power Engineering	Faculty of Engineering
Course Title: Gas Turbine Engines	Total Marks: 75 Marks Course Code: MEP4232	Year: 4^{th}
Date: 12-6-2010 (Second term)	Allowed time: 3 hrs	No. of Pages: (2)

Remarks: (Answer as much as you can ....Assume any missing data......All questions carry equal marks)

Question 1: (15 Marks)

A. Sketch the velocity diagram for an axial flow compressor, derive an expression for the degree of reaction and show that for 50% reaction, the blades are symmetrical ;i.e.; $\alpha1=\beta2$ and $\alpha2=\beta1$.

B. An axial flow compressor has a tip diameter of 0.95m and a hub diameter of 0.85m. The absolute velocity of air makes an angle of 28° measured from the axial direction and relative velocity angle is 56°.The absolute velocity outlet angle is 56° and the relative velocity outlet angle is 28°. The rotor rotates at 5000 rpm and the density of air is $1.2 kg/m^3$.
Determine: 1.The axial velocity. 2.The mass flow rate. 3.The power required. 4.The flow angles at the hub. 5.The degree of reaction at the hub.

Question 2: (15 Marks)

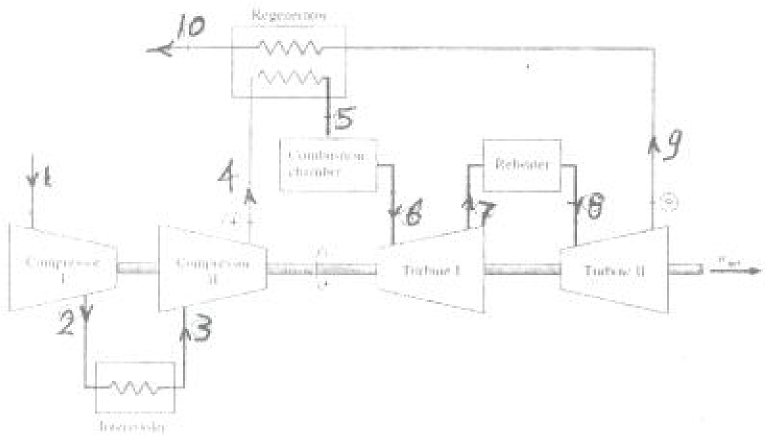
A. For fixed maximum and minimum temperatures, show the effect of the pressure ratio on: (a) the thermal efficiency and (b) the net work output of a simple ideal Brayton cycle?

B. Determine the specific thrust and SFC (specific fuel consumption) for a turbojet engine having the following component performance at the design point at which the cruise speed is M=0.8 at altitude 10 km where Pa=0.265 bar and Ta=223.3K, compressor pressure ratio=8, turbine inlet temperature=1200K, Isentropic efficiency of compressor η_c=0..87, of turbine η_t=0.9, of intake, η_i=0.93, of propelling nozzle η_n=0.95, mechanical transmission efficiency η_m=0.99, combustion efficiency η_b=0.98, combustion pressure loss ΔP_b=0.04 of compressor delivery pressure, theoretical fuel/air ratio is 0.0194. Check if the nozzle is choked or not. Assume $(k-1)/\ \eta_n(k+1) = 1-(P_{cr}/P_5)^{(k-1)/k}$, $T_5/T_{cr}=(k+1)/2$ where point 5 is the nozzle inlet condition.

Question 3: (15 Marks)

A. If the inlet state and the exit pressure are specified for a two-stage compressor operating at steady state, show that the minimum total work input is required when the pressure ratio is the same across each stage. Use a cold air-standard analysis assuming that each compression process is isentropic, there is no pressure drop through the intercooler, and the temperature at the inlet to each compressor stage is the same.

B. A gas-turbine plant operates on the regenerative Brayton cycle with two stages of compression and two-stages of expansion between the pressure limits of 100 and 1200 kPa. The working fluid is air. The air enters the first and the second stages of the compressor at 300 K and 350 K, respectively, and the first and the second stages of the turbine at 1400 K and 1300 K,



respectively. Assuming both the compressor and the turbine have an isentropic efficiency of 80 percent and the regenerator has an effectiveness of 75 percent, determine (a) the back work ratio and the net work output, and (b) the thermal efficiency

Continued

Question 4: ((15 Marks)

A. Consider the ideal regenerative Brayton cycle. Determine the pressure ratio that maximizes the thermal efficiency of the cycle and compare this value with the pressure ratio that maximizes the cycle net work. For the same maximum to- minimum temperature ratios, explain why the pressure ratio for maximum efficiency is less than the pressure ratio for maximum work.

B. In a single-stage axial flow gas turbine gas enters at stagnation temperature of 1100 K and stagnation pressure of 5 bar. Axial velocity is constant through the stage and equal to 250 m/s. Mean blade speed is 350 m/s. Mass flow rate of gas is 15 kg/s and assume equal inlet and outlet velocities. Nozzle efflux angle is 63°, stage exit swirl angle equal to 9°.Determine the rotor-blade gas angles, degree of reaction, and power output.

Question 5: (15 Marks)

A. What are the differences between turbojet, turbofan, and turboprop engine? Why some turbojets are equipped with an afterburner?

B. A turbojet aircraft is flying with a velocity of 320 m/s at an altitude of 9150 m where atmospheric pressure Pa=32 kPa and temperature ta = -32°C.. The pressure ratio across the compressor is 12, and the temperature at the turbine inlet is 1400 K. Air enters the compressor at a rate of 60 kg/s, and the jet fuel has a heating value of 42,700 kJ/kg. Assuming ideal operation for all components and constant specific heats, determine:

(i) the velocity of the exhaust gases,

(ii) the thrust force and propulsive power developed.

(iii) the propulsive efficiency, and

(iv) the rate of fuel consumption.

C. Repeat Problem B using a compressor efficiency of 80 % and a turbine efficiency of 85%.

Best Wishes

Course Examination Committee:

1- Prof. Dr. Abd Elnaby Kabeel

2- Dr. Gamal Bedair.

Course Coordinator: Prof. Abd Elnaby Kabeel

Assume:

c_p for air = 1.004 kJ/kg. K

c_p for combustion gases = 1.1 kJ/kg. K,

$\gamma_a = 1.4$ and $\gamma_g = 1.33$.

Assume any missing data.

ميكانيكا قوى جديد

Tanta University
Faculty of Engineering
Time: 3hr
Dr/ Talal Abou Elmaaty

May -2010
Desalination

1 a - For a single effect evaporation (SEE) proves that the performance ratio has the following form;

$$\frac{\lambda_s}{(\lambda_v + C_p(T_v - T_f)\frac{X_f}{X_b - X_f} + \frac{X_f}{X_b - X_f} C_p BPE)}$$

1-b

A TVC system generates a distillate product at a flow rate of 1 kg/s. The system operating temperatures are as follows:

- The boiling temperature, T_b, is 90 °C.
- The feed temperature, T_f, is 85 °C.
- The compressed vapor temperature, T_s, is 102 °C.
- The motive steam pressure, P_m, is 15 bar.

Determine the heat transfer areas in the evaporator and the condenser, the thermal performance ratio, the flow rates of feed seawater and reject brine, and the flow rate of cooling seawater. Assume the following:

- The specific heat of seawater and brine streams is constant and equal to 4.2 kJ/kg °C.
- Neglect thermodynamic losses in the demister and during condensation.

for X_f = 42000 ppm, X_b = 70000 ppm, and M_d = 1 kg/s

2-

Design a single stage RO desalination system by calculating the permeate salinity, the brine salinity, the brine flow rate, and the membrane area. Analyze the following cases:

Water permeability is 2.05×10^{-6} m³/m² s kPa
Salt permeability is 2.03×10^{-5} m³/m² s
Feed salinity is 34.000 ppm

Feed flow rate: 2.5 kg/s
Permeate flow rate: 1 kg/s
Feed pressure: 6000 kPa
Reject pressure: 5800 kPa
Permeate pressure: 101 kPa

3-

Calculate the performance ratio, specific heat transfer area, specific flow rate of cooling water, conversion ratio, and salinity of brine blowdown for a single stage flash desalination unit operating at the following conditions:

Feed salinity = 50000 ppm
Feed temperature = 25 °C
Heating steam temperature = 90 °C
Production capacity = 1 kg/s
Brine blowdown temperature = 35 °C
Top brine temperature = 80 °C
Terminal temperature difference in the condenser = 3 °C
Thermodynamic losses = 2 °C.

Assuming the overall heat transfer coefficient for both the heater and the condenser are equal; $U_h = U_c = 1.9$ kW/ m². °C

4-

A single-effect mechanical vapor-compression system is to be designed at the following conditions:

- The distillate flow rate, M_d = 1 kg/s.
- The heat capacity of the vapor is constant, C_{p_v} = 1.884 kJ/kg °C.
- The heat capacity of all liquid streams is constant, C_p = 4.2 kJ/kg °C.

- **The overall heat transfer coefficient in the evaporator, brine pre heater and the Product pre heaters are 2.0, 2.0 and 1.5 kJ/s. m^2.°c respectively**
  - The intake seawater temperature, T_{cw} = 25°C.
  - The condensed vapor temperature, T_d = 62 °C.
  - The compressed vapor temperature, $T_s = T_d + 3 = 65$ °C.
  - The evaporation temperature, $T_b = T_d - 2 = 60$ °C.
  - The feed seawater salinity, X_f = 42000 ppm.
  - The salinity of the rejected brine, X_b = 70000 ppm.
  - Compressor efficiency, η = 58.9%

Calculate the specific power consumption, the heat transfer areas for the evaporator and preheaters, and the specific heat transfer area.

Important correlations

$$TCF = 2\times10^{-8}\ (T_c)^2 - 0.0006\ (T_c) + 1.0047$$

$$PCF = 3\times10^{-7}\ (P_m)^2 - 0.0009\ (P_m) + 1.6101$$

$$Ra = 0.296 \frac{(P_s)^{1.19}}{(P_{ev})^{1.04}} \left(\frac{P_m}{P_{ev}}\right)^{0.015} \left(\frac{PCF}{TCF}\right)$$

$$\begin{aligned} BPE = & \left[0.083 + 0.000197T_b + 0.000004T_b^2\right]X_b \\ & + \left[-0.00076 + 0.00009T_b - 0.0000005T_b^2\right]X_b^2 \\ & + \left[0.00015 - 0.000003T_b - 0.000000003T_b^2\right]X_b^3 \end{aligned}$$

$$\lambda(T) = 2501.9 - 2.407T + 1.192\times10^{-3}T^2 - 1.586\times10^{-5}T^3$$

$$U_e(T) = 1.9695 + 1.2057\times10^{-2}T - 8.599\times10^{-5}T^2 + 2.565\times10^{-7}T^3$$

$$U_c(T) = 1.7194 + 3.2063\times10^{-3}T + 1.597\times10^{-5}T^2 - 1.992\times10^{-7}T^3$$

$$M_s\ \lambda_s = M_f\ C_p\ (\Delta T_{st} + \Delta T_{loss} + TTD_c)$$

$$M_d\ \lambda_v = M_f\ C_p\ \Delta T_{st} = (M_f + M_{cw})\ C_p\ (T_o - \Delta T_{st} - \Delta T_{loss} - TTD_c - T_{cw})$$

$$(LMTD)_h = (\Delta T_{st} + \Delta T_{loss} + TTD_c)/\ln((TTD_h + \Delta T_{st} + \Delta T_{loss} + TTD_c)/(TTD_h))$$

$$(LMTD)_c = (\Delta T_{st})/\ln((\Delta T_{st} + TTD_c)/(TTD_c))$$

$$PR = (\lambda_s)(\Delta T_{st})/((\Delta T_{st} + \Delta T_{loss} + TTD_c)\ (\lambda_v))$$

le A.11: Variation in saturation temperature of water vapor (°C) as a funct
turation pressure (kPa)

P (kPa)	Calculated Temperature (°C)	Temperature from Steam Tables (°C)	Percentage Error
0.8721	5.004311	5	0.086223
1.2276	9.977515	10	0.224647
1.705	14.95766	15	0.282249
2.339	19.94942	20	0.252867
3.169	24.93937	25	0.242503
4.246	29.93817	30	0.206098
5.628	34.94124	35	0.167869
7.384	39.94826	40	0.128338
9.593	44.95588	45	0.098035
12.35	49.96858	50	0.062849
15.758	54.98005	55	0.036208
19.941	59.99471	60	0.008819
25.03	65.00619	65	0.009523
31.19	70.02479	70	0.035412
38.58	75.03961	75	0.052814
47.39	80.05217	80	0.065212
57.83	85.06356	85	0.074765
70.14	90.07796	90	0.086612
84.55	95.08715	95	0.091739
101.3	100.0830	100	0.083897
120.8	105.1006	105	0.095797
143.3	110.1166	110	0.106
169.1	115.1215	115	0.105474
198.5	120.1106	120	0.092129
232.1	125.1186	125	0.094893
270.1	130.1129	130	0.086868

A.12: Variation in water vapor specific volume (m^3/kg) as a function of
rature (°C)

T (°C)	Calculated Specific Volume (m^3/kg)	Specific Volume from Steam Tables (m^3/kg)	Percentage Error
5	147.07980	147.117	0.025285
10	106.37933	106.376	0.003132
15	77.93664	77.925	0.014937
20	57.79882	57.7897	0.017517
25	43.36557	43.3593	0.014456
30	32.89601	32.8932	0.008551
35	25.21619	25.2158	0.001542
40	19.53198	19.5229	0.004735
45	15.25660	15.2581	0.009804
50	12.03025	12.0318	0.012911
55	9.56703	9.56835	0.013787
60	7.66972	7.67071	0.012899
65	6.19591	6.19656	0.010432
70	5.04182	5.04217	0.00686
75	4.13113	4.13124	0.002424
80	3.40722	3.40715	0.001964
85	2.82774	2.82757	0.006085
90	2.36078	2.36056	0.009143
95	1.98200	1.98186	0.011082
100	1.67311	1.6729	0.012267
105	1.41953	1.41936	0.011952
110	1.21027	1.21014	0.010649
115	1.03666	1.03658	0.007642
120	0.89189	0.89186	0.003796
125	0.77059	0.77059	0.000286
130	0.66848	0.6685	0.003484
135	0.58213	0.58217	0.007239
140	0.50880	0.50885	0.010324
145	0.44627	0.44632	0.012189
150	0.39273	0.39278	0.012659
155	0.34672	0.34676	0.0112

ميكانيكا قوى قديم

Tanta University

Department: Electrical Power and Machines Engineering
Total Marks: 70 Marks

Faculty of Engineering

Course Title: Electric Power	Course Code:	Year: 4^{th}
Date: June 2010 (Second Term)	Allowed time: 3 hrs	Mech

Answer the following questions

Problem number (1) **(15 Marks)**

a) A three-phase, 50 Hz, 220 kV transmission line of 10 km length has the following constants: Conductor resistance per km is 0.069 ohm and Conductor reactance per km is 0.4698 ohm. When the line delivers 80.0 MW at 220 kV with 0.8 lagging power factor, calculate the sending voltage, the full load voltage regulation and the efficiency. (7 Marks)

b) A 100 km, single circuit, three-phase transmission line delivers 60 MVA at 0.85 lagging power factor to a load at 132 kV. The line has the following constants: Conductor resistance per km is 0.15 ohm, Conductor reactance per km is 0.3 ohm and Shunt susceptance is $2x10^{-6}$ mho. Determine by using (π-representation):

- The sending end voltage, current, power factor, real and reactive power.
- The full-load voltage regulation and the efficiency.

Problem number (2) **(15 Marks)**

a) A transmission line has a span of 150-m between level supports. The cross section area of the conductor is 1.25 cm^2 and weight 1 kg/m. If the breaking stress is 4220 kg/cm^2. Calculate the safety factor if the sag of the line is 3.5 m. Assume a maximum wind pressure of 50 kg/cm^2. (7 Marks)

b) An overhead line has a cross section area of 2.2 cm^2. Weight of conductor = 1.4 kg/m. Ultimate strength = 8000 kg/cm^2, wind pressure = 40 kg/m^2 of projected area. Calculate the vertical sag of the line for a span of 300 m, assuming a factor of safety is 3.

Problem number (3) **(15 Marks)**

a) Describe the current growth phenomenon in gas dielectrics under uniform electric fields as explained by Townsend's theory. (5 Marks)

b) A gas with a first ionization coefficient of 5.4 cm^{-1} is used as an insulator between two electrodes 0.8 cm apart. Calculate the second ionization coefficient just before breakdown. Calculate the required spacing between the electrodes to get a current of 0.05 μA at the anode surface if the initial current is 4 nA

Problem number (4) **(15 Marks)**

a) Explain the phenomena of electrical conduction in liquids. How does it differ from that in gas?

b) Explain briefly the various theories that explain breakdown in commercial liquid dielectrics.

c) Calculate the surface tension of an insulating liquid contain a globule with 1.1 μm radius and ε_{r2} = 1.2 with a voltage drop of 180 volt across it. The liquid has ε_{r1} = 2.3 and the breakdown field strength is 488.85 kV.

Problem number (5) **(10 Marks)**

Explain briefly the different mechanisms by which breakdown occurs in solid dielectrics

A solid dielectric has relative permittivity of 4 and a Young's modulus of 160 kg/cm^2. Calculate the highest apparent electric stress before breakdown.

Good Luck

Course Examination Committee

Dr. Mohamed Abo Elazm

ميكانيكا قوى نظام قديم

TANTA UNIVERSITY FACULTY OF ENGINEERING MECH. POWER DEPART. FOURTH YEAR (لائحة قديمة)	advanced air conditioning summer semester 2010 Time allowed: 3 hours date: June 2010

Please, answer the following questions:

1) *A regenerative type air coolng system, which is used in the supersonic military aircrafts, is designed to take a load of 15 T.R. when the aeroplane is moving at a Mach number 1.4. The temperature and pressure conditions of atmosphere are 5^oC & 0.85 bar. The pressure of air is increased from 0.85 to 1.2 bar due to ramming action with a ram diffuser efficiency of 95%. The pressure of air leaving the main compressor is 4.2 bar. The ram air heat exchanger is 45%effective. The air from the heat exchanger passes on to the cooling turbine. Some portion of the air after expanding in the cooling turbine passes through the shell side of the regenerative heat exchanger reducing the temperature of the main compressed air to 109.4^oC. The cooling air from the turbine gets heated in the regenerative heat exchanger to 105.5^oC before discharged. The isentropic efficiencies of the compressor and the cooling turbine are 80% and 70% respectively. The cabin is pressurized to 1.013 bar and maintained at 25^oC. Determine:*
   a) *the ratio of the air extracted from cooling turbine for regenerative cooling of the ram air,*
   b) *The mass flow rate of air supplied to the air conditioning system,*
   c) *The horse power required for maintaining the cabin at the desired conditions,*
   d) *Coefficient of performance of the system.*

2.1) *Deduce a relation for calculating the optimum diameter of air ducts used in central air-conditioning systems.*

2.2) *A duct system consists of a fan and a 25 m length of circular duct that delivers 800 L/S of air. The installed cost is estimated to be 200 E.P per square meter of galvanised sheet metal (ε = 0.15 mm). The power cost is 10 P.T per kilowatt-hour. The fan efficiency is 55% and the motor efficiency is 85%. The operating time during the amortization period is 10000 hours. Assuming that the friction factor for the galvanised sheet metal is 0.02, what is the optimum diameter of the duct.*

ميكانيكا قوى

Tanta University

Department: Mech. Power Engineering
Total Marks: 20 Marks

Faculty of Engineering

Course Title: Hydraulic circuit Date: June 2010 (Final second term)	Course Code: MEP4229 Allowed time: 3 hrs	Year: 4th No. of Pages:2

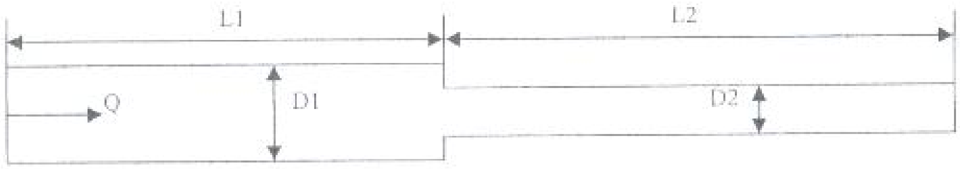
Remarks: (answer the following questions and assume any missing data

Problem number (1) **(30 Marks)**

1- Discus briefly the advantages and disadvantages of hydraulic power systems.

2- Explain the principals of operation and the possible applications and types of hydraulic accumulators in hydraulic systems. / Calculate the size of accumulator necessary to deliver 5 litres of oil between pressures of 200 and 100 bar (gauge pressure), charging pressure is 90 bars.

3- Calculate the pressure losses in the given pipe line, given as shown in figure:
-Flow rate Q = 0.125 L/min -fluid density ρ = 850 kg/m3 - L1 = L2 = 4m - D1= 13 mm - D2 = 8 mm - Fluid kinematics viscosity $\nu = 1.95 \times 10^{-5}$ m²/s



Problem number (2) **(30 Marks)**

1- Calculate the displacement volume, delivery pulsation coefficient, input power and driving torque of a gear pump of the following parameters: n= 2500 rpm, number of teeth =12, module = 3.5 mm, tooth width = 20 mm, pressure angle = 20 deg., inlet pressure = 0.2 MPa, exit pressure = 15 MPa, mechanical efficiency = 0.85, volumetric efficiency = 0.9

2- Discus in detail the modeling of the hydraulic transmission lines assuming lumped parameters. Derive the transfer function matrix relating the input and output pressures and flow rates.
Find the transfer function relating the pressures at both ends of a closed end line, given: Line length L = 3m, ρ = 867 kg/m³, μ = 0.13 Pas, and B = 1GPA

3-Explain the different methods of mechanical locking and mechanical mounting of hydraulic cylinders.